

**Al Mansoura University**

**Faculty of Engineering**

**Electronics and Communications Dept.**

**2<sup>nd</sup> Year Students**

**Logic Circuit 2**

**First Semester 2013**

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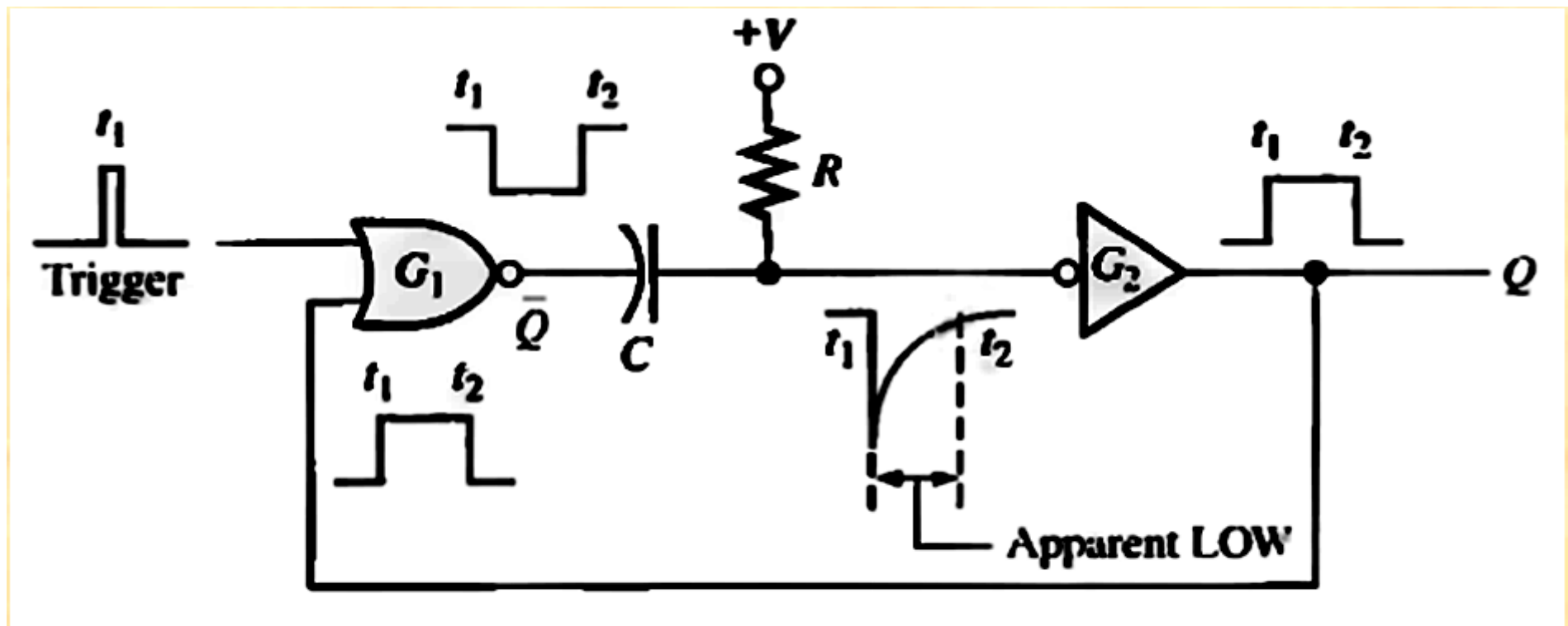
**Chapter 1: Latches**

**Lecture No. 4**

### 1.12-One Shots.

- ✓ The **one-shot** is a **monostable multivibrator**, a device with only **one stable** state.
- ✓ A one-shot is **normally** in its **stable** state and will **change** to its **unstable** state only when **triggered**.
- ✓ Once it is **triggered**, the one-shot **remains** in its **unstable** state for a **predetermined length** of time and then **automatically returns** to its **stable** state.
- ✓ The **time** that the device **stays** in its **unstable** state determines the **pulse width** of its output.

- ✓ **Figure 1.24** shows a **basic one-shot** (monostable multivibrator) that is **composed** of a **logic gate** and an **inverter**.

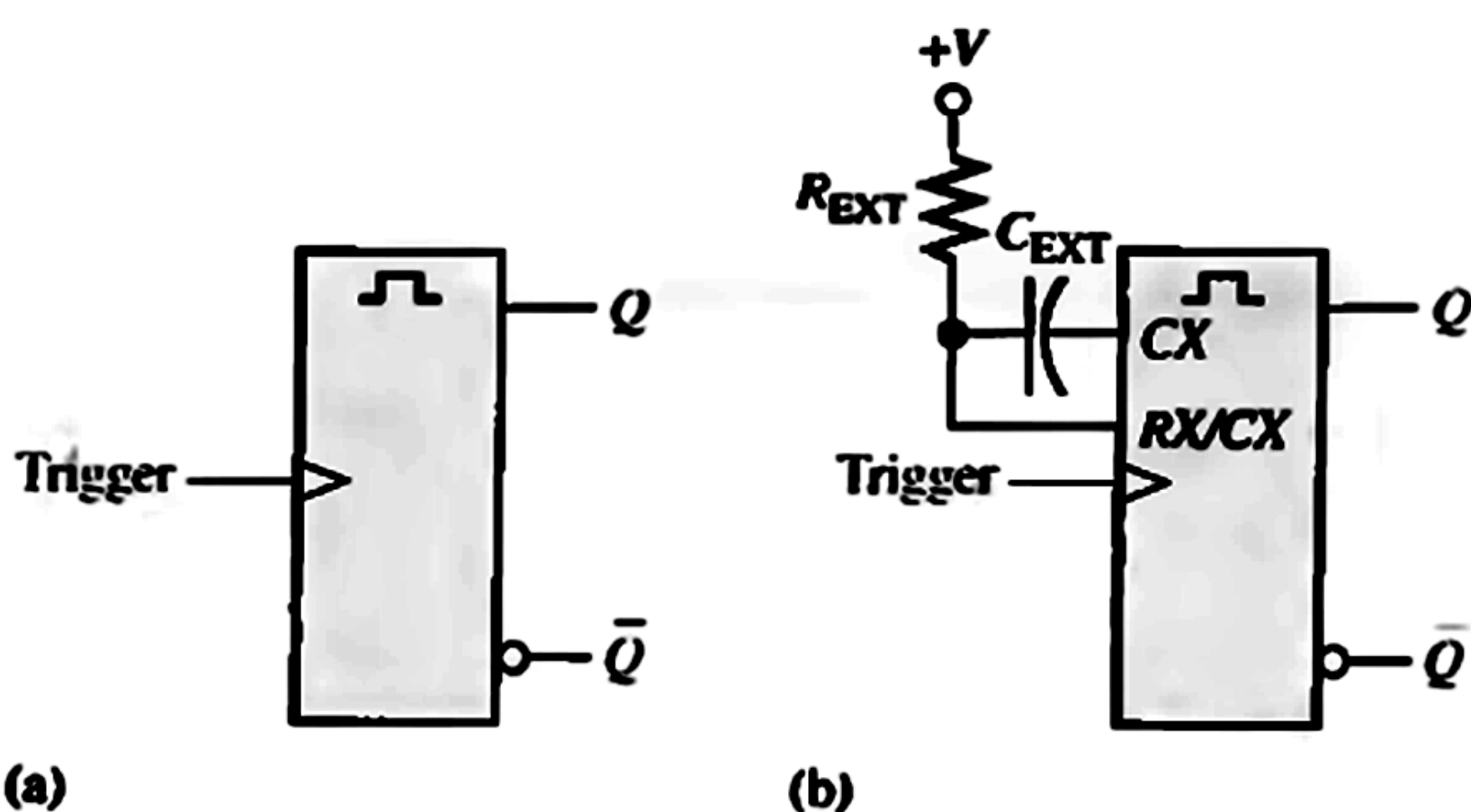


**Figure (1.24)** A simple **one-shot circuit**.

- ✓ When a **pulse** is applied to the **trigger input**, the output of gate  $G_1$  goes **LOW**. This **HIGH-to-LOW** transition is coupled through the **capacitor** to the input of **inverter**  $G_2$ .
- ✓ The **apparent LOW** on  $G_2$  makes its output go **HIGH**.
- ✓ This **HIGH** is connected back into  $G_1$  keeping its output **LOW**.
- ✓ Up to this point the **trigger pulse** has caused the output of the one-shot,  $Q$ , to go **HIGH**.

- ✓ The **capacitor** **immediately** begins to **charge** through R toward the **high voltage** level. The **rate** at which it **charges** is determined by the **RC time constant**.
- ✓ When the **capacitor charges** to a certain level, which appears as a **HIGH** to  $G_2$  the output goes back **LOW**.
- ✓ To **summarize**, the output of **inverter**  $G_2$  goes **HIGH** in response to the **trigger** input. It remains **HIGH** for a time set by the **RC time constant**. At the end of this time, it goes **LOW**.

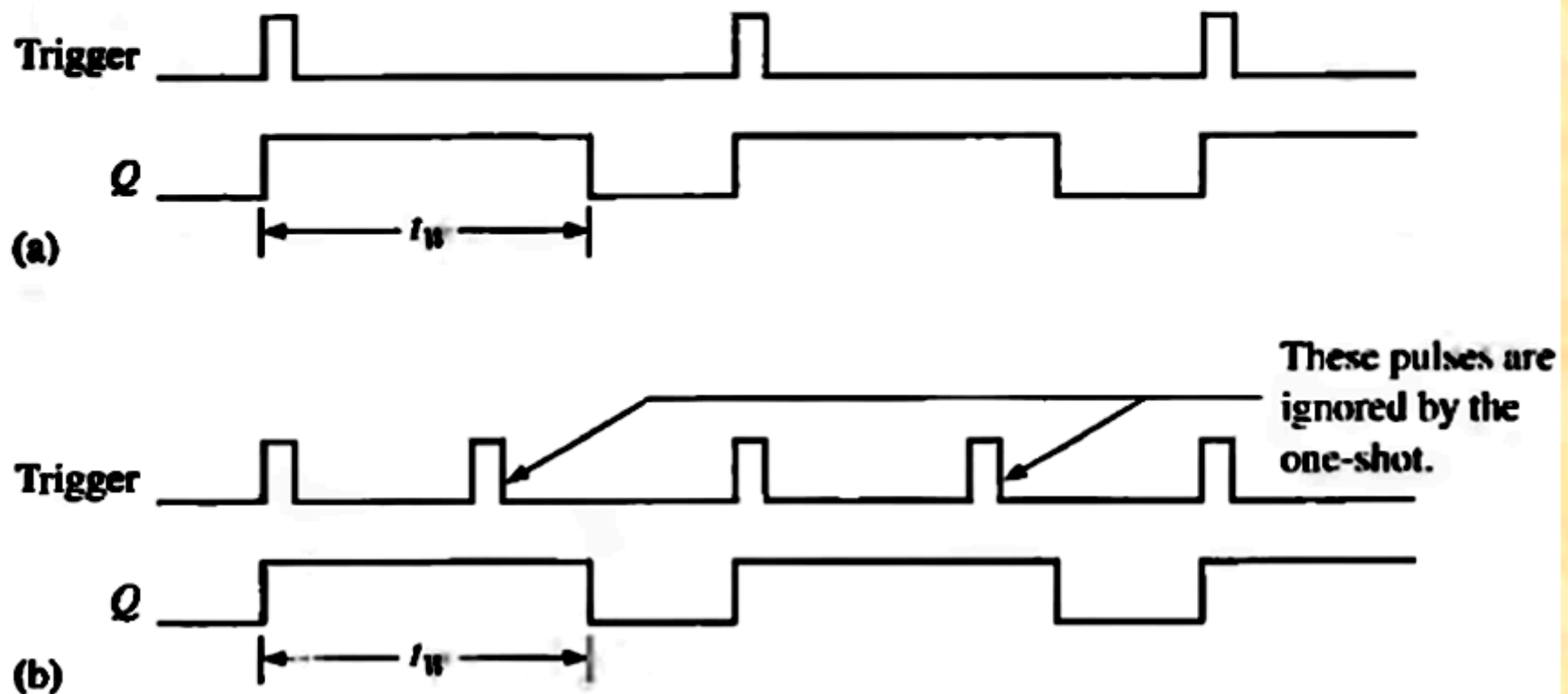
- ✓ A single **narrow trigger** pulse produces a **single output** pulse whose **time duration** is controlled by the **RC time constant**. This operation is illustrated in Figure 1.24.



- ✓ A **typical** one-shot **logic symbol** is shown in Figure 1.25(a), and the same symbol with an **external** R and C is shown in Figure 1.25(b).
- ✓ The **two basic** types of IC one-shots are **nonretriggerable** and **retriggerable**.
- ✓ A **nonretriggerable** one-shot **will not respond** to any additional **trigger pulses** from the time it is **triggered into** its **unstable state** until it **returns** to its **stable state**.
- ✓ In **other words**, it **will ignore** any **trigger pulses** occurring **before** it times out. The **time** that the one-shot **remains** in its **unstable** state is the **pulse width** of the output.

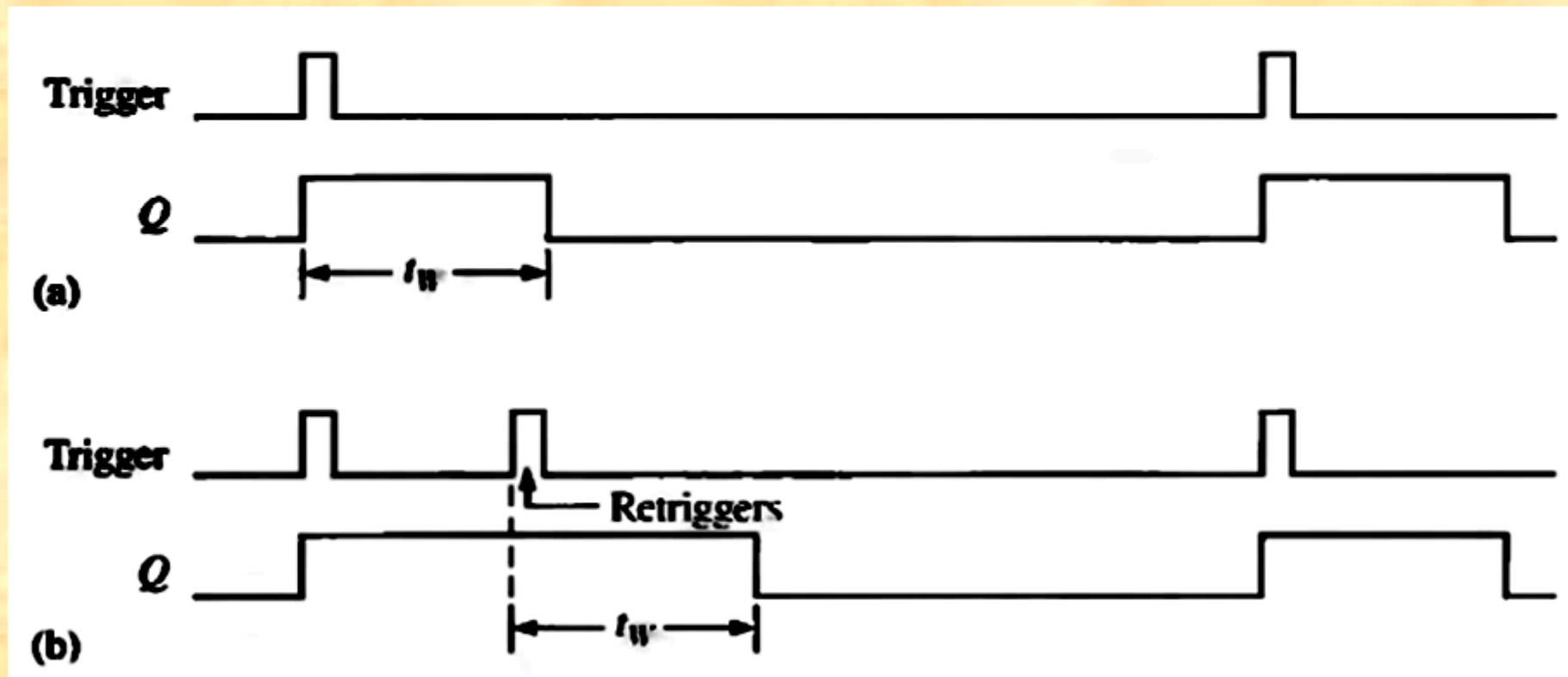


- ✓ Figure 1.26 shows the **nonretriggerable** one-shot being **triggered** at intervals **greater than** its pulse width and at **intervals less** than the pulse width. Notice that in the **second case**, the **additional** pulses are **ignored**.





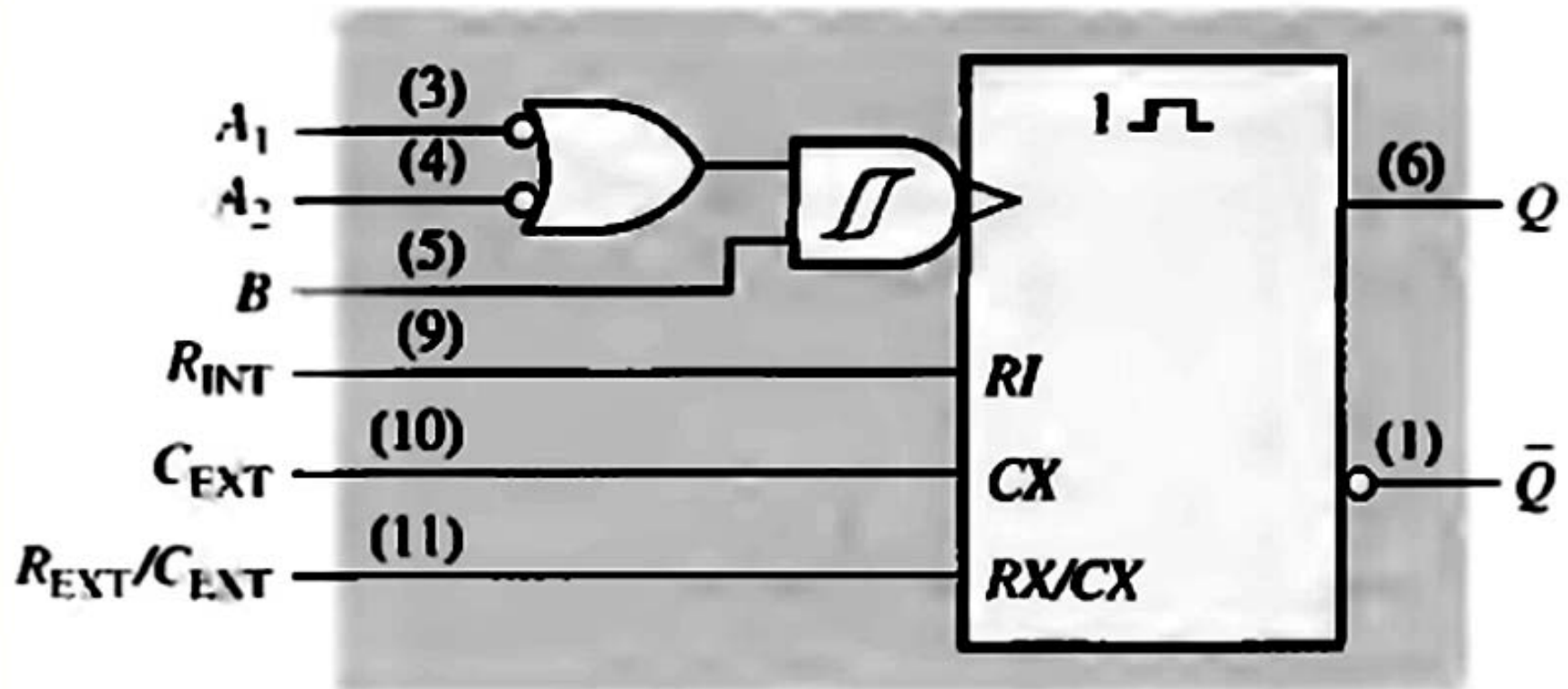
- ✓ A **retriggerable one-shot** can be **triggered** before it times out. The result of **retriggering** is an **extension** of the pulse width as illustrated in Figure 1.27.



**Figure (1.27) Retriggerable one-shot action.**

### 1.12.1-The 74121 Nonretriggerable One Shot.

- ✓ The **74121** (TTL) is an example of a **nonretriggerable** IC one-shot. It has **provisions** for **external** R and C, as shown in Figure (1.28). The **inputs** labeled  $A_1$ ,  $A_2$ , and B are **gated trigger** inputs. The **R<sub>INT</sub>** input connects to a **2k $\Omega$  internal timing** resistor.



(a) Traditional logic symbol

**"1⌞"** is the **qualifying symbol** for a **nonretriggerable** one-shot.

### 1.12.2-Setting the Pulse Width.

- ✓ A **typical pulse** width of about **30 ns** is produced when **no external** timing components are used and the **internal timing** resistor ( $R_{INT}$ ) is connected to  $V_{CC}$ , as shown in Figure 1.29(a).

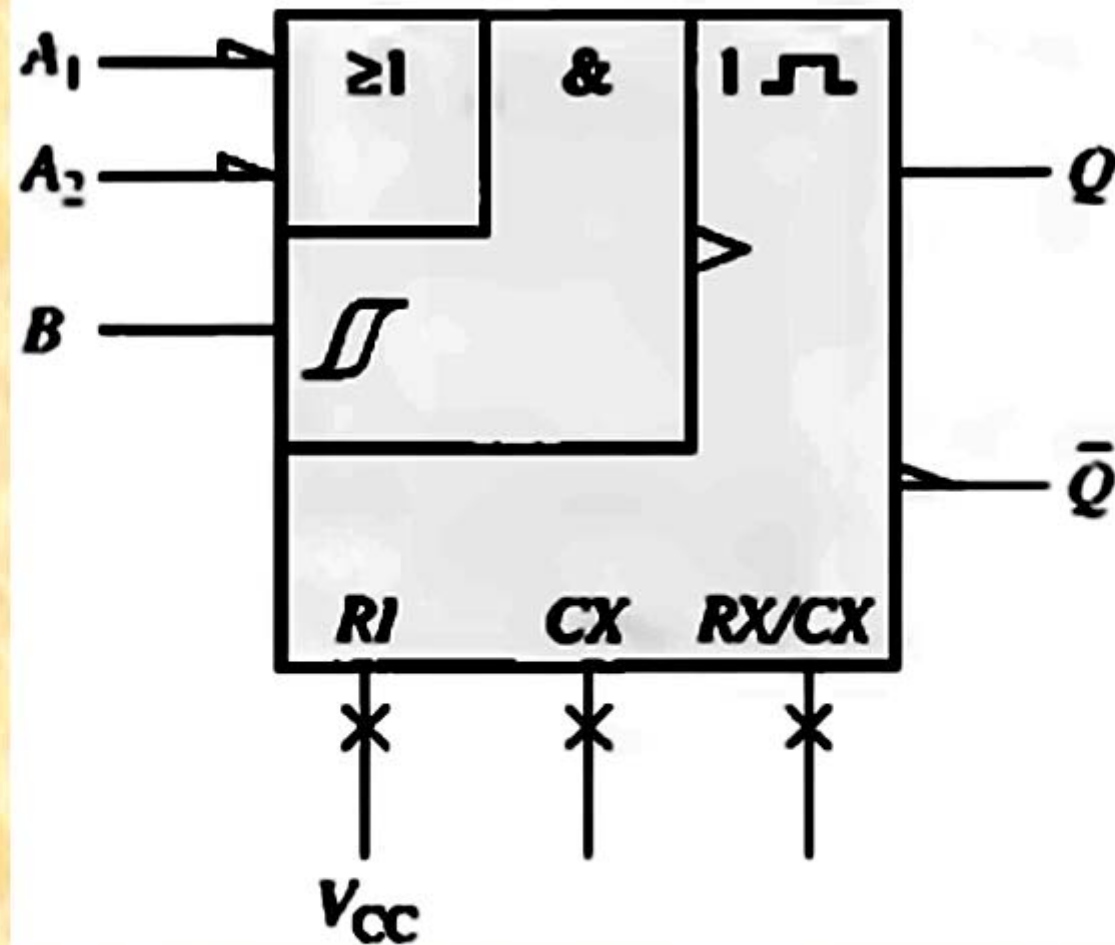
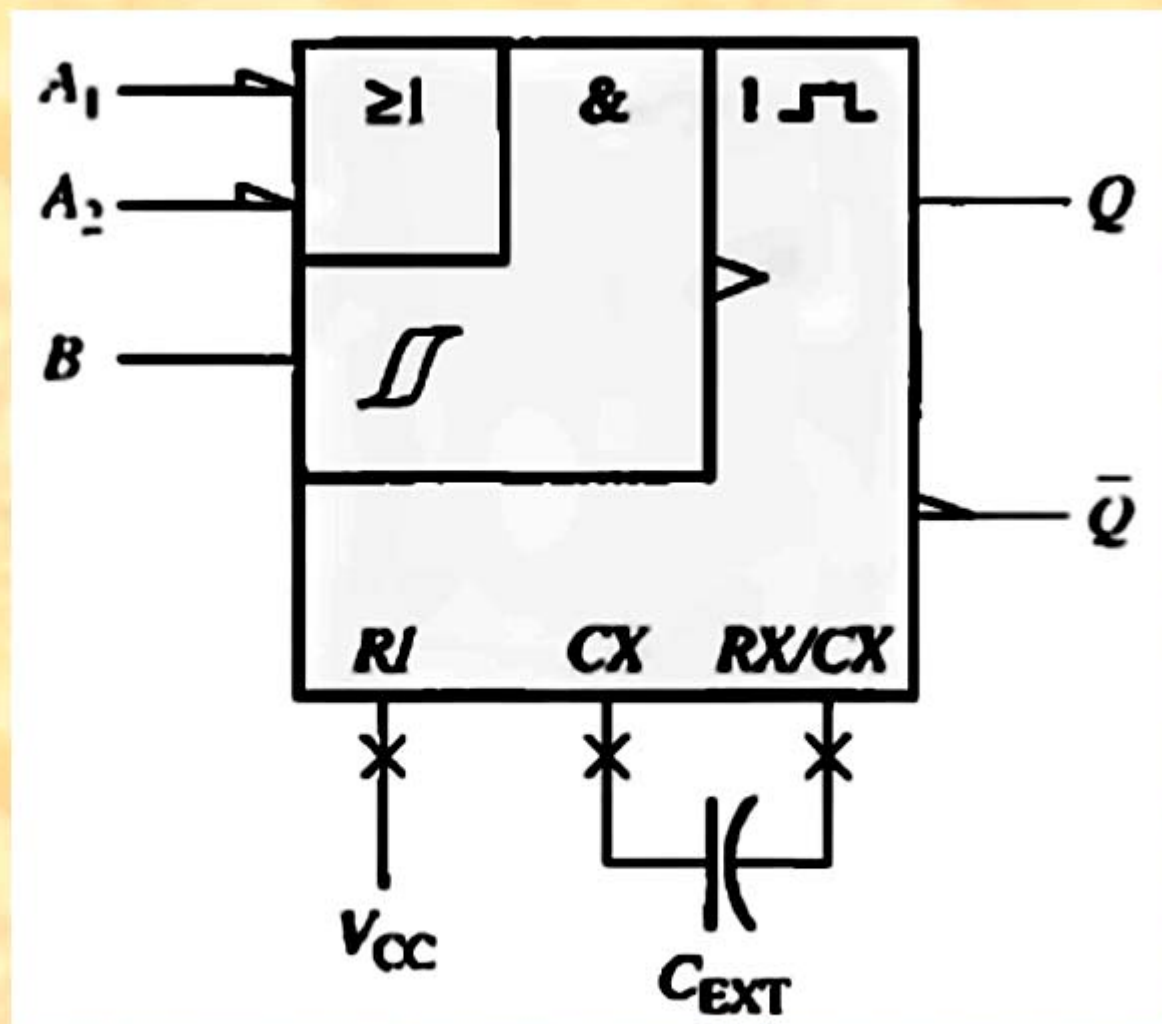


Figure (1.29)-(a) **No external** components  $R_{INT}$  to  $V_{CC}$ ,  $t_W = 30\text{ns}$

✓ The **pulse width** can be set anywhere between about **30 ns** and **28 s** by the use of **external components**. Figure (1.29)(b) shows the configuration using the **internal resistor** ( $2\text{ k}\Omega$ ) and an external capacitor.



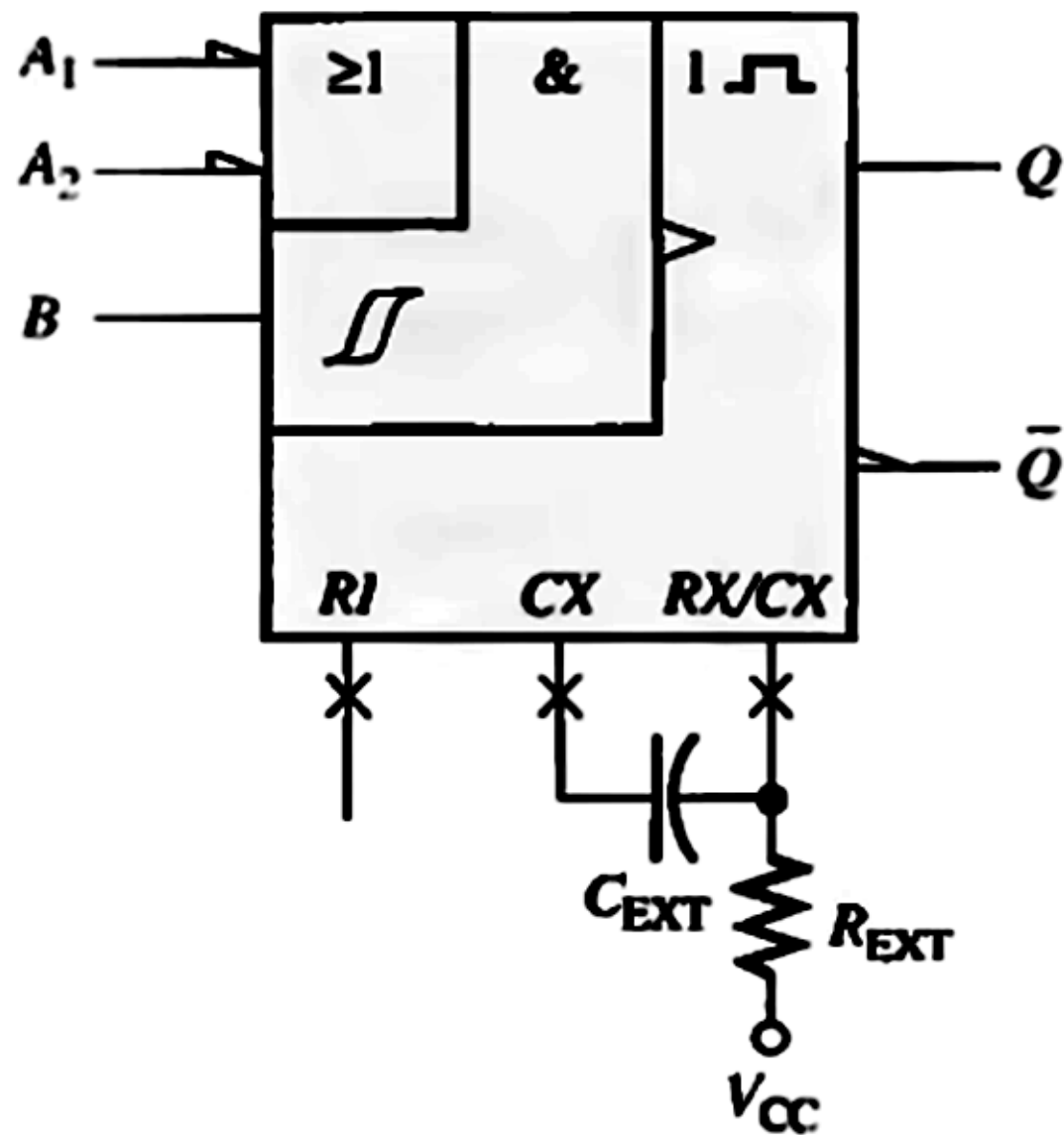


**Figure (1.29)(b)**  $R_{INT}$  and  $C_{EXT}$ ,  $t_W = 0.7 \times 2k\Omega \times C_{EXT}$

- ✓ Figure (1.29)(c) shows the configuration **using** an **external resistor** and an **external** capacitor.
- ✓ The **output pulse** width is set by the values of the resistor (**R<sub>INT</sub>** = 2 kΩ, and **R<sub>EXT</sub>** is selected) and the capacitor according to the following formula:


$$t_W = 0.7 \times R \times C_{EXT}$$

- ✓ Where **R** is either **R<sub>INT</sub>** or **R<sub>EXT</sub>**. When **R** is in **kilohms** (kΩ) and **C<sub>EXT</sub>** is in **picofarads** (pF), the output pulse width **t<sub>W</sub>** is in **nanoseconds** (ns).



**Figure (1.29)(c)**  $R_{EXT}$  and  $C_{EXT}$   $t_W = 0.7 R_{EXT} C_{EXT}$

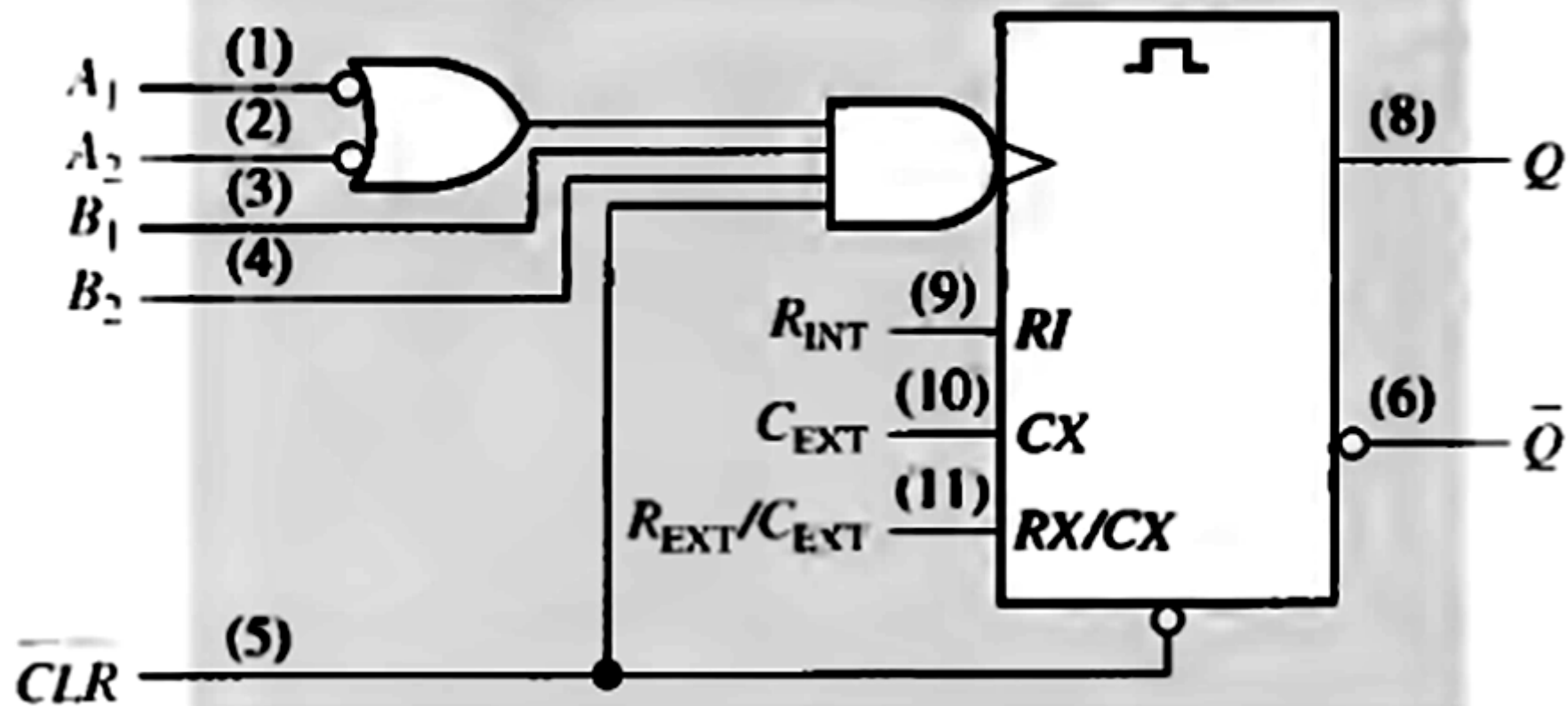
### 1.12.3-The Schmitt-Trigger Symbol

- ✓ The symbol  indicates a **Schmitt-trigger** input. This **allows** reliable **triggering** to occur even when the input is **changing** as **slowly** as 1 volt/second.

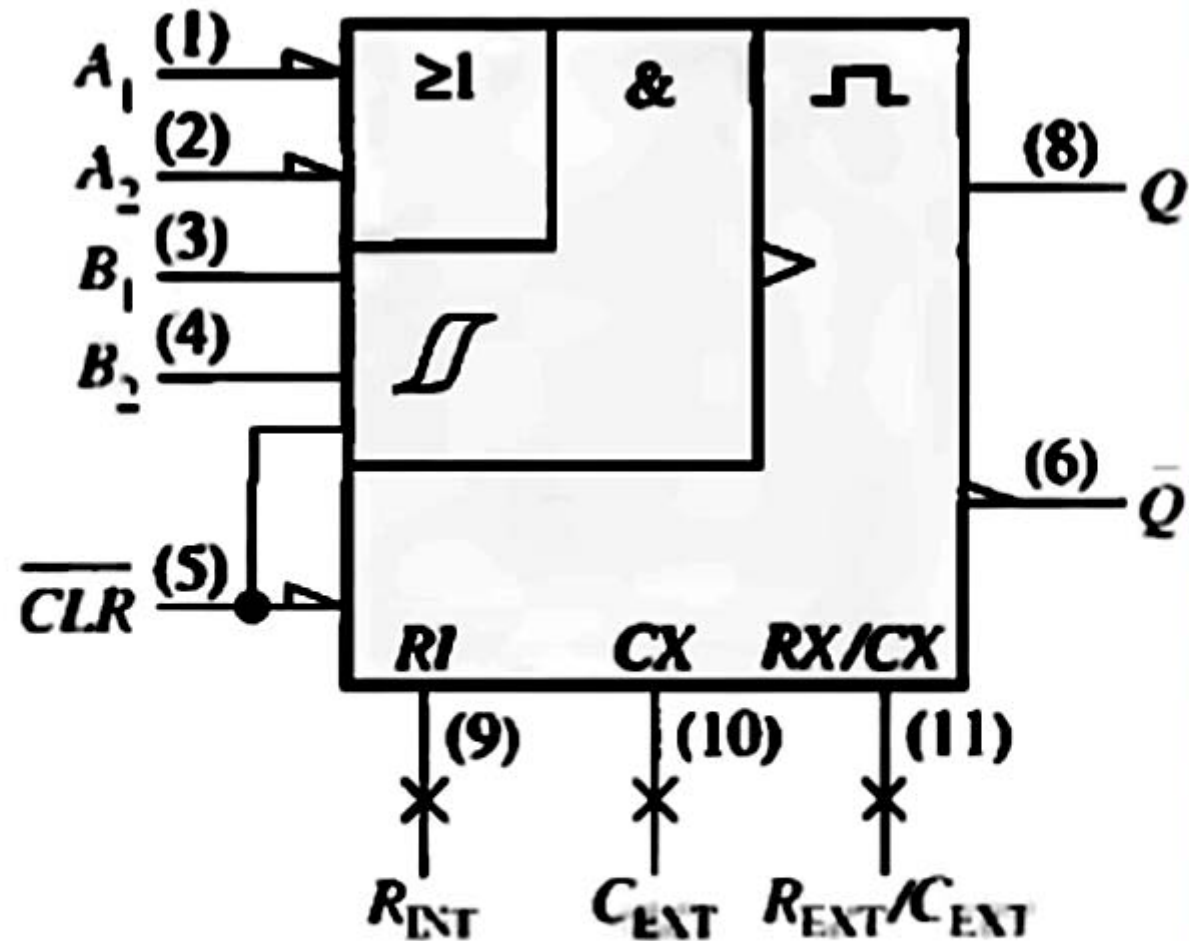
### 1.12.4- The 74LS122 Reteriggerable One Shot.

- ✓ The **74LS122** is an example of a **retriggerable IC** one-shot with a **clear** input.
- ✓ It also has **provisions** for **external** R and C. as shown in Figure (1.30). The inputs labeled A<sub>1</sub> A<sub>2</sub>, B<sub>1</sub> and B<sub>2</sub> are the

**gated** **trigger** inputs.



**Figure (1.30)(a)** Traditional logic symbol



**Figure (1.30)(b)** ANSI/IEEE logic symbol (X = **nonlogic connection**).  is the qualifying symbol for a **retriggerable**



- ✓ A **minimum pulse** width of approximately **45 ns** is obtained with **no external** components. **Wider** pulse widths are achieved by using **external components**.
- ✓ A **general formula** for calculating the values of these components for a specified pulse width ( $t_W$ ) is:

$$t_W = 0.32 R C_{EXT} \left( 1 + \frac{0.7}{R} \right)$$

- ✓ Where **0.32** is a **constant** determined by the **particular type** of one-shot,  $R$  is in  $k\Omega$  and is either the **internal** or the **external** resistor,  $C_{EXT}$  is in pF, and  $t_W$  is in ns.



- ✓ The **internal resistance** is  $10\text{ k}\Omega$  and can be used **instead** of an **external** resistor.

**Example 1.11** A certain application requires a one-shot with a pulse width of approximately **100 ms**. Using a **74121**, show the connections and the component values.

**Solution:**

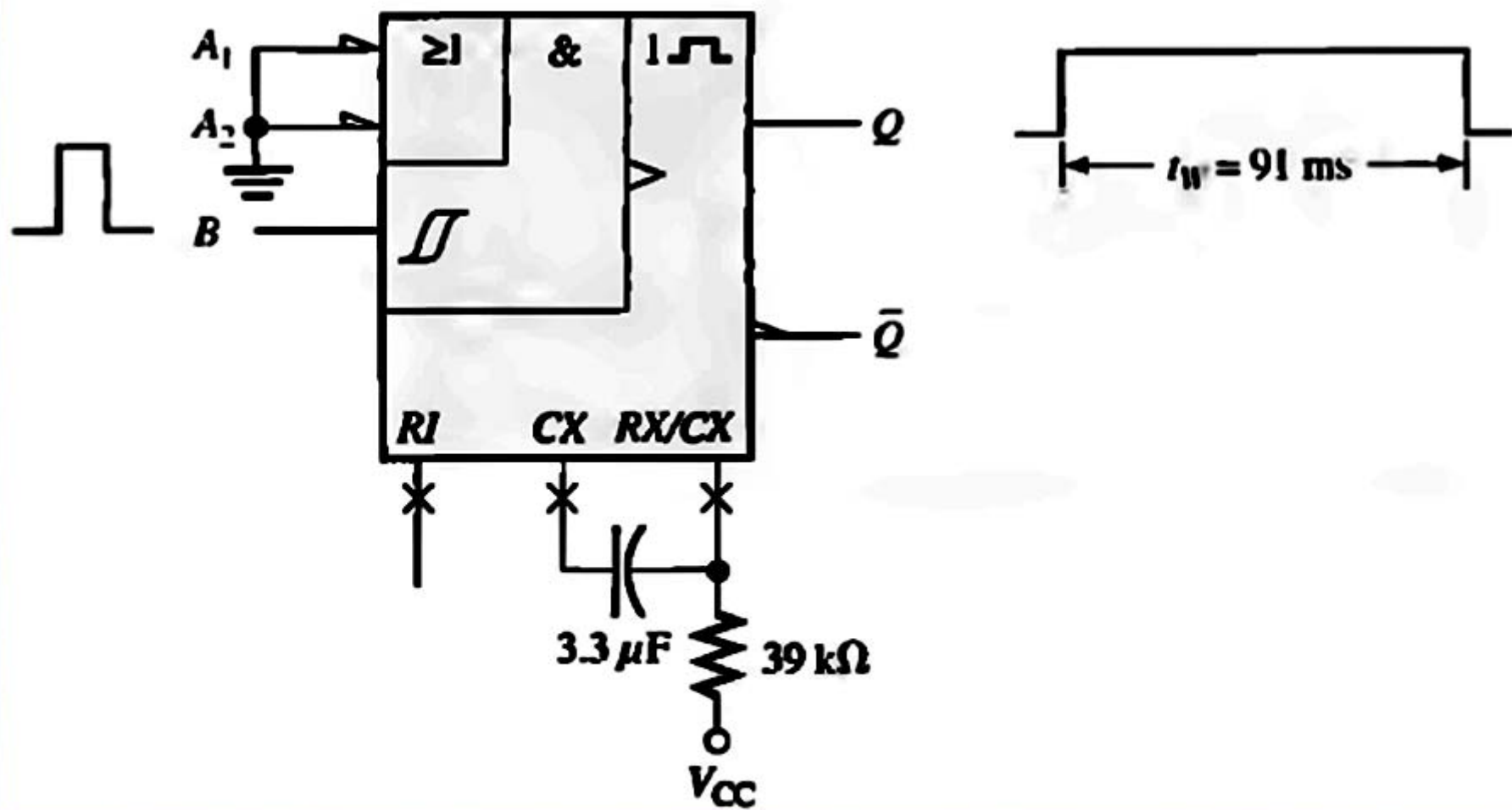
- ✓ **Arbitrarily select**  $R_{\text{EXT}} = 39\text{ k}\Omega$  and **calculate** the **necessary** capacitance.

$$t_W = 0.7 \times R_{\text{EXT}} \times C_{\text{EXT}}$$

$$C_{\text{EXT}} = \frac{t_w}{0.7 \times R_{\text{EXT}}}$$

$$C_{\text{EXT}} = \frac{100 \times 10^{-3}}{0.7 \times 39 \times 10^3} = 3.66 \mu\text{F}$$

- ✓ A **standard 3.3  $\mu\text{F}$**  capacitor will give an output pulse width of **91 ms**.
- ✓ The proper connections are shown in Figure (1.31).



**Figure (1.31)**

- ✓ To **achieve** a **pulse** width closer to **100 ms**, other **combinations** of values for  $R_{EXT}$  and  $C_{EXT}$  can be tried.
- ✓ **For example**,  $R_{EXT} = 68 \text{ k}\Omega$  and  $C_{EXT} = 2.2 \text{ }\mu\text{F}$  gives a pulse width of **105 ms**.

**Example 1:12** Determine the values of  $R_{EXT}$  and  $C_{EXT}$  that will produce a pulse width of  $1 \text{ }\mu\text{s}$  when connected to a **74LS122**.

**Solution:**

- ✓ Assume a value of  $C_{EXT} = 560 \text{ pF}$  and then solve for  $R_{EXT}$ .

$$\mathbf{t_W = 0.32 \times R_{EXT} \times C_{EXT} \left( 1 + \frac{0.7}{R_{EXT}} \right)}$$

$$\mathbf{t_W = 0.32 \times R_{EXT} \times C_{EXT} + 0.32 \times C_{EXT} \times 0.7}$$

$$\mathbf{R_{EXT} = \frac{t_W - 0.32 \times 0.7 \times C_{EXT}}{0.32 \times C_{EXT}}}$$

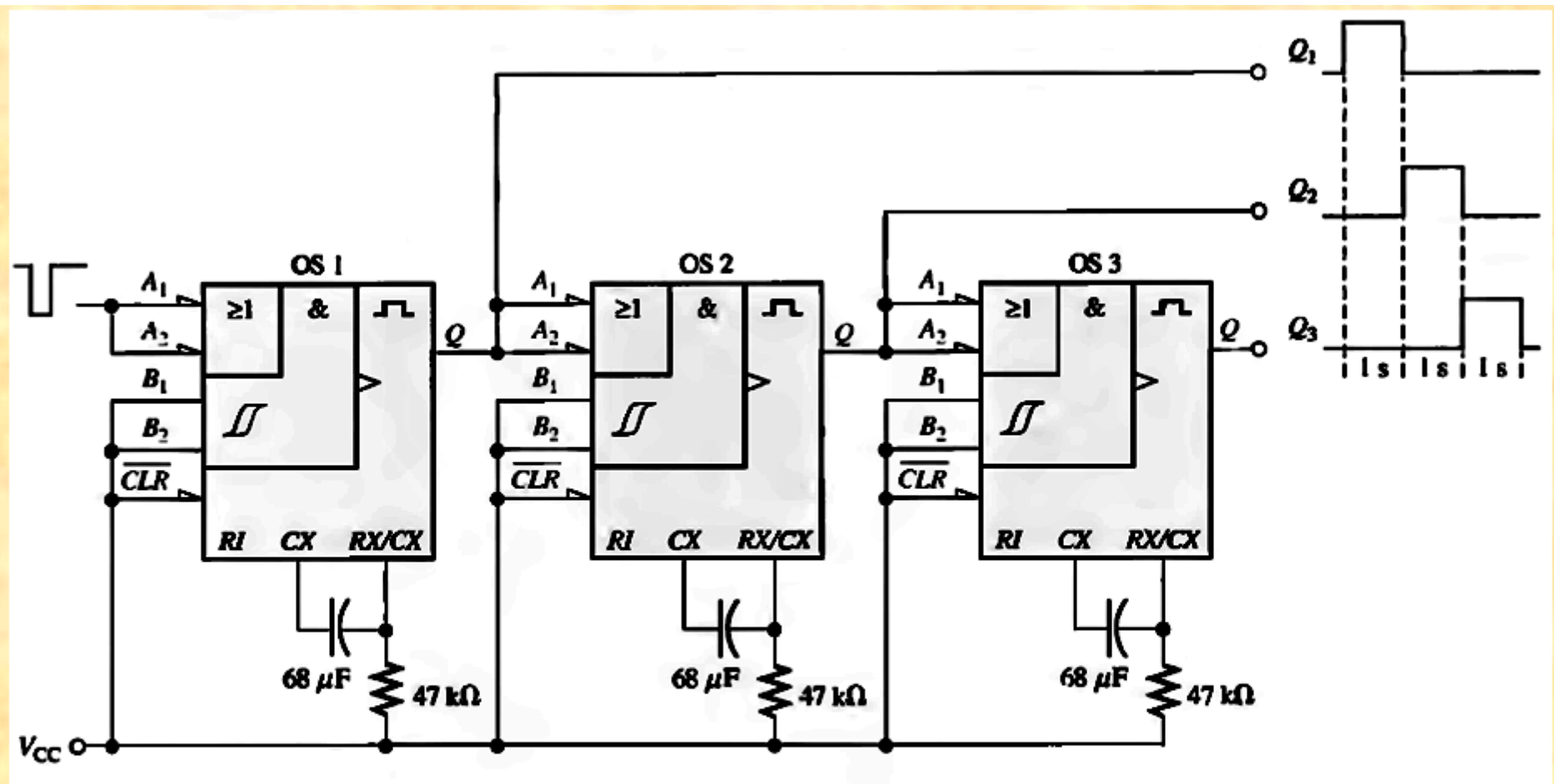
$$\mathbf{R_{EXT} = \frac{t_W}{0.32 \times C_{EXT}} - 0.7}$$

$$\mathbf{R_{EXT} = \frac{10^{-6}}{0.32 \times 560 \times 10^{-12}} - 0.7 = 5.58 \text{ k}\Omega}$$

### 1.12.5-An Application.

- ✓ **One** practical one-shot application is a sequential timer that can be used to illuminate a series of lights.
- ✓ This type of circuit can be used, for example, in a lane change directional indicator for highway construction projects or in sequential turn signals on automobiles.
- ✓ **Figure** (1.32) shows three 74LS122 one-shots connected as a sequential timer. This particular circuit produces a sequence of three 1s pulses.





**Figure (1.32)** A **sequential** timing circuit using three **74LS122** one-shots.



- ✓ The **first one-shot** is triggered by a **switch** closure or a **low-frequency** pulse input, producing a 1s output pulse.
- ✓ When the **first one-shot** (OS1) times out and the 1s pulse goes **LOW**, the **second one shot** (OS2) is **triggered**, also producing a 1s output pulse.
- ✓ When this **second pulse** goes **LOW**, the **third one-shot** (OS3) is **triggered** and the third 1s pulse is produced.
- ✓ The output timing is illustrated in the figure. Variations of this basic arrangement can be used to produce a variety of timed outputs.